MONITORING AND REMEDIAL MEASURES FOR THE 10 MILE DRAIN SITE

FINAL REPORT

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LIST OF ACRONYMS

AEW	Anderson Eckstein & Westrick, Inc.
CIPP	Cured-in-place pipe
ECT	Environmental Consulting & Technology, Inc.
EPA	U.S. Environmental Protection Agency
MCPWO	Macomb County Public Works Office
MDEQ	Michigan Department of Environmental Quality
mg/kg	Milligrams per kilogram
NPL	National Priorities List (aka: Superfund Site List)
PCB	Polychlorinated biphenyl
ppb	Parts per billion (equivalent to µg/l)
ppm	Parts per million (equivalent to mg/kg)
TMD	10 Mile Drain storm sewer system including laterals and the Harper Ave. Drain
µg/l	Micrograms per liter

1.0 INTRODUCTION

1.1 PROJECT GOALS & OBJECTIVES

The purpose of this project was to obtain more relevant information with regard to the polychlorinated biphenyls (PCBs) that are affecting the 10 Mile Drain system (TMD) in an effort to better protect the public and the environment. This was accomplished by conducting additional assessment and interim response activities throughout the TMD.

The project goal was achieved between September 2007 and September 2011 by completing of the following objectives:

- Design, fabrication and use of an innovative sediment removal and storm water treatment system to clean out portions of the storm drain,
- Installation of weirs throughout the storm drain to inhibit the migration of PCBs to Lake St. Clair and to assist in source assessment efforts,
- Installation of two additional monitoring wells, one of which has a collection sump for PCB oil to accumulate, and
- Perform environmental sampling to gain a better understanding of the nature, extent and dynamics of the PCB contamination in the groundwater, surface water and sediments in proximity to the 10 Mile Drain site.

Due to the initial findings of this project, the U.S. Environmental Protection Agency (EPA) Response Section was reengaged in November 2009 to re-clean a portion of the drain and conduct preliminary source investigations. They also fabricated and installed most of the weirs, which allowed local resources to be redirected toward additional sample collection. The site was also evaluated by the Michigan Department of Environmental Quality (MDEQ) and added to the National Priorities List (NPL) in September 2010. Subsequent to the NPL listing, the EPA Remedial Section conducted additional source investigations in March/April 2011. Although the activities conducted by the MDEQ and EPA are not the subject of this report, they are mentioned throughout to give the reader a more complete understanding of the site.

Interim sampling summary progress reports were prepared for the MDEQ throughout the project period and were shared with the EPA to aid with their ongoing investigations. These summary reports were also posted to the City's website. This report details the comprehensive results of the environmental monitoring and remedial measures conducted over the project period.

This report has been divided into six sections. The remainder of the **Introduction** section provides a description of the project area, background information, describes roles and responsibilities of the involved agencies and provide a timeline of activities. **Section 2.0 Monitoring Methods** discusses the monitoring site locations, analytical methods and sample collection methods. **Section 3.0 Drain Cleaning & Weir Installation** describes the design and operation of the sediment extraction/stormwater treatment system, the timing and location of the weirs and the installation and replacement of the oil snares. **Section 4.0 Monitoring Results**

summarizes the results of the routinely collected samples for groundwater, surface water, sediment and oil, and the results of a brief investigation that was conducted after oil was discovered at Harper Ave. and Bon Brae St. **Section 5.0 Conclusions** provides the findings of the project. Finally, **Section 6.0 Recommendations** describes future monitoring and interim remedial activities that are suggested for the site.

1.2 Project Area Description

The 10 Mile Drain Site is located northeast of the City of Detroit and on the western shore of Lake St. Clair, Macomb County, Michigan. The site encompasses a several block area where polychlorinated biphenyls (PCBs) have been documented to be present in significant quantities in an underground storm sewer drain system. This sewer system is comprised of the 10 Mile Drain, Harper Ave. Drain and various laterals and is abbreviated TMD throughout this report. The TMD provides storm water drainage for 275 acres of residential and commercial land located in St. Clair Shores, Michigan. The larger sections of the TMD are approximately 15 feet underground, range in diameter from 48" to 104"and empty into the 10 Mile/Lange/Revere canals that drain to Lake St. Clair (see Figure 1). Ownership of the TMD is divided between the City of St. Clair Shores (SCS) who maintains the laterals and the Macomb County Public Works Office (MCPWO) who maintains the larger sections of the drain along Harper Ave, Bon Brae St., Jefferson Ave. and 10 Mile Rd.

1.3 Background

In the fall of 2001, elevated levels of polychlorinated biphenyls (up to 150 mg/kg) were discovered in the Lange/Revere Street canals which are located along Lake St. Clair in SCS. Shortly thereafter, the conduit of the contamination to the canals was identified to be the TMD.

After a great deal of investigation conducted by SCS, Macomb County, the State and EPA, a portion of the TMD in the vicinity of Bon Brae St. and Harper Ave. was identified as having the highest PCB concentration. This investigation included extensive sampling of the stormwater drainage network, completion of a corridor investigation to determine the potential responsible party(ies), historical drain record review and interviews of the local residents.

A remediation effort followed that included removal of 6,000 cubic yards of hazardous (PCB concentration > 50 mg/kg) material (sediment, fish, vegetation and other debris) and 35,000 cubic yards of non-hazardous regulated material from the storm sewer network and canals. After the contamination persisted in the TMD, an additional 200 cubic yards of hazardous material was removed from the outlet sediment trap and 600 cubic yards of surface soils (mostly non-hazardous) were removed from residential yards.

Initially, it was hypothesized that the contamination was caused by a one-time dump to the storm sewer, and once the material was removed the contamination would cease. Unfortunately PCB contamination persisted in the sewers. After additional investigation, it appeared more likely that pocket(s) of contaminated material sitting around the storm sewer was slowly leaching into the sewer. In 2006 to alleviate further transport of contaminated material to the storm sewer and downstream canals, a CIPP liner was installed in the portion of the storm sewer with the most elevated PCB concentrations. The liner, along with three installed slurry walls, was designed to prevent any further migration of PCB contaminated material.

1.4 Roles & Responsibilities

This project was funded by the Michigan Department of Environmental Quality (MDEQ) via a grant to SCS and the MCPWO. Project oversight was provided by SCS and the MDEQ. SCS contracted with Environmental Consulting & Technology, Inc. (ECT) to carry out the majority of tasks associated with this project. The City's engineer, Anderson, Eckstein & Westrick, Inc. (AEW), assisted with completing the design for the monitoring well/collection sump (MW6) and by designing, fabricating and installing some of the weirs in the storm drain. With the exception of one sample, all samples were analyzed by Paragon Laboratories, Inc. RTI Laboratories, Inc. analyzed the one sample collected on 9/14/09.

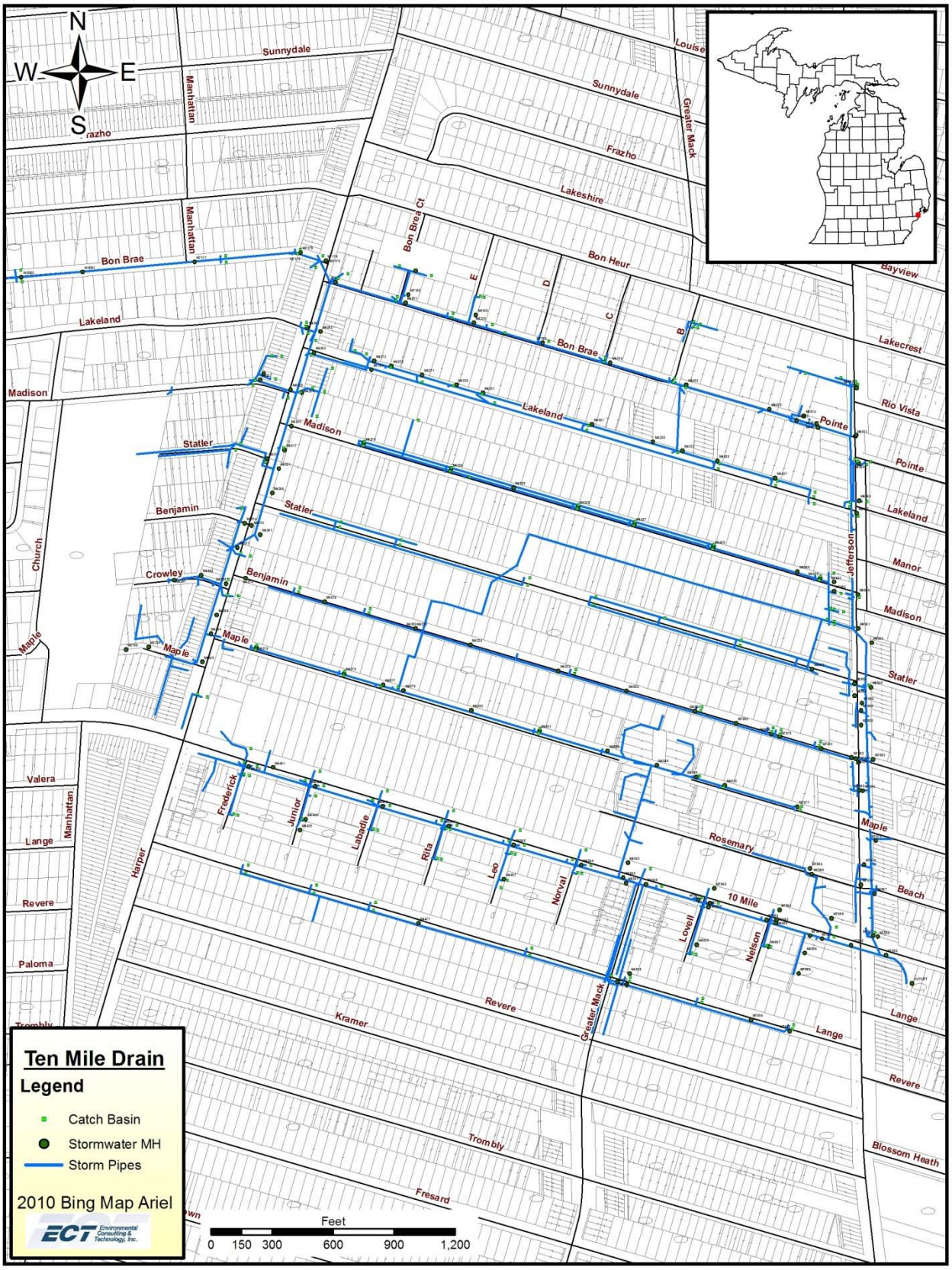
1.5 Timeline of Activities

The project period extended from September 30, 2007 – September 30, 2011. The timeline showing the major activities conducted during this period (both EPA and grant-funded) is presented in Table 1. Unless otherwise noted, activities were carried out by SCS via their consultants.

Table 1. Timeline of Field Activities

Date	Activity
Sept 2007	Grant awarded
Nov 2007	Developed sampling plan
Jan 2008	Conducted initial sampling
Jan – Sept 2008	Designed/fabricated/modified treatment system
Mar 2008	Installed monitoring well (MW5)
Oct-Nov 2008 and Sept – Dec 2009	Drain cleaned out with treatment system
Jan 2009	Released status report
Jun 2009	Installed monitoring well (MW6)
Dec 2009	Held public meeting
Dec 2009	Removed accumulated oil (EPA)
Mar/Apr 2010	Cleaned out drain by dewatering (EPA) Conducted source investigations (EPA)
Apr 2010	Completed weir installation (EPA)
May 2010 – Aug 2011	Conducted routine sampling
Jan 2011	Released sampling summary
Mar/Apr 2011	Conducted source investigations (EPA)
May 2011	Released sampling summary
Jun 2011	Released sampling summary
Sept 2011	Conducted canal sampling (EPA)

Figure 1. Project Area



2.0 MONITORING METHODS

2.1 WELL INSTALLATION

Samples were collected from six wells over the course of the project: two wells were installed during the project period, while the other four monitoring wells (MW1 – MW4) were installed by ECT and the EPA prior to the start of project. Monitoring wells MW5 and MW6 were installed on March 20, 2008 and June 16, 2009, respectively. MW5 is a standard, 2 inch monitoring well installed within the drain trench. MW6 was also installed within the drain trench; however, it was oversized and included a sump to enable collection of any contaminated groundwater or oil that had accumulated in the TMD trench. The boring logs and design for MW6 are provided in Appendix A. Note that the boring log for MW4 was not available.

2.2 GROUNDWATER AND STORM WATER METHODS

Static groundwater levels and storm water levels at two locations within the TMD were monitored continuously during a portion of the project. The water level data was converted to elevation so it could be compared across the project site.

Groundwater samples were collected from the six monitoring wells and surface water samples were collected at the drain outlet throughout the project. The samples were collected following the methods outlined in the *10 Mile Drain Sampling Plan for Environmental Monitoring* dated November 30, 2007.

2.3 SEDIMENT AND WEIR MONITORING METHODS

Initial sediment sampling was conducted in January 2008 to determine the quantity of sediment and PCB concentration of the sediment that had accumulated after installation of the CIPP liner in 2006. These sediment samples were collected following the methods outlined in the *10 Mile Drain Sampling Plan for Environmental Monitoring* dated November 30, 2007.

Following the March/April 2010 drain cleanout and installation of weirs, sediment monitoring continued from May 2010 to August 2011.

During this “post-weir installation” period, sample collection procedures were modified to sample the oil that was accumulating in the TMD and to monitor the condition of the oil snares. A sampling probe (consisting of a length of 1” PVC pipe with a 90° elbow) was used to estimate the thickness of sediment in the drain. The probe was lowered into the manhole until the technician could feel resistance indicating the presence of sediment/debris. The probe was pushed through the sediment/debris and the thickness of material was noted. The sample probe was withdrawn from the manhole and inspected for the presence of oil. If oil was present, the elbow was cut from the probe and containerized for subsequent analysis of the oil. At times the oil would collect inside the elbow and at other times it would just adhere to the outside of the elbow.

Whether or not sediment was detected in the manhole, a petite ponar dredge was released up to three times to collect a sediment sample. Retrieved material from the dredge was collected in a stainless steel bowl, organic and inorganic debris was removed, and the material was homogenized and transferred to a laboratory jar for subsequent analysis.

Oil snare strings were installed in select manholes in February 2011 to reduce the migration of oil collecting in the TMD. If oil snares were in a manhole, they were removed prior to any measurements or sediment sample collection, so subsequent monitoring activities could be carried out. The oil snares were evaluated and inspected for the presence of oil. Wearing nitrile gloves, a member of the field team would run their hands through the snares while looking for brown coloring indicating the presence of oil. Once the physical inspection of the snares was complete, the gloves were rinsed into the drain with water. If a brown substance remained on the gloves or if the field team visually identified oil on the snares, the snares were containerized for subsequent disposal. At this point, sediment sampling proceeded in the manner described above. Once sampling was completed, the snares (new or used) were reinstalled.

All samples were analyzed for Total PCBs using EPA method 8082A.

A detailed description of all the monitoring locations is provided in Appendix B.

3.0 DRAIN CLEANING & WEIR INSTALLATION

3.1 SEDIMENT REMOVAL/STORM WATER TREATMENT SYSTEM

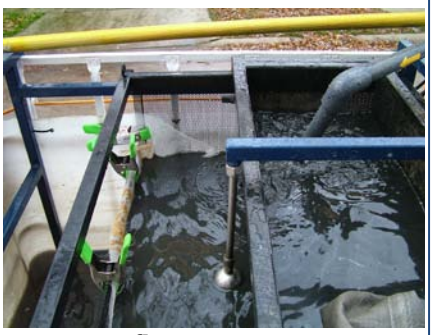
Due to the recontamination of the TMD discovered in 2005, it was necessary to re-clean PCB contaminated material from within the drain to 1) prevent it from migrating to the canals and 2) provide a proper baseline for monitoring once the weirs were installed. Historically, contaminated material was removed by dewatering the drain (due to the presence of standing lake water), jetting out any contaminated material, and vacuuming out the material. The material would then need to dewater before it could be disposed of in a landfill. This process, carried out previously by EPA and MCPWO, was costly, so a more cost effective method was desired.

To address this concern, a portable sediment removal/storm water treatment system was designed and fabricated during the project. The treatment system consisted of a suction head, pumps, course screens, settling tank, and various filters as shown in Appendix C. The treatment system was mounted on a 16 foot trailer and powered by a 13 hp gas generator. The system operated by pumping a sediment/storm water slurry from the drain bottom to a collection tote. The slurry was then pumped through a series of filters and the water was returned back to the drain.

The MDEQ-issued permit for the treatment system (Permit #: MI0058489) specified an effective total PCB effluent limit of 0.2 µg/L[1]. Through various trial runs, the field crew was able to achieve this permit limit through adjustments to the filter media and size, increased filter replacement rate and reduction of the effluent flow rate to 2 gpm. Once all treatment modifications were completed in fall 2009, the effluent limit was generally achieved, even when influent concentrations were as high as 6,100 mg/kg. System treatment efficiency was as high as 99.999% even when influent concentrations were 70,000 mg/kg (see Table 2).

Between October 2008 and December 2009, the treatment system was used to clean the TMD at select locations (see Figure 2). Thirty drums (approximately 1,500 gallons) of contaminated sediment, filter fabric and debris were disposed of and 27,000 gallons of storm water were treated during this time.

Treatment System - Overview



System Influent at Coarse Screens

Bag and Carbon Filters

Clean Treated Effluent

[1] The actual specified effluent limit was 0.000026 µg/l; however, analytical methods only allow for detection down to 0.2 µg/L. Therefore, the effective effluent permit limit was 0.2 µg/L.

Figure 2. Locations Cleaned using the Sediment Removal/Storm Water Treatment System

Additional permit-required data was collected and reported to the MDEQ during cleaning operations. This data includes PCB data from an intermediate sample location and suspended sediment, dissolved oxygen and pH data from the effluent. All analytical data associated with the treatment system operation are provided in Appendix D.

While attempting to clean out manholes M7183 (Bon Brae at the D Street (vacated)) and M7178 (southwest corner of Bon Brae and Harper) in November 2009, an unusual amount of oil was observed in the treatment system influent. This observation was consistent with the oil that was seen on the suction pan in November 2008. The oil was sampled from the manholes in November 2009 and found to have total PCBs at 98,000 and 820,000 mg/kg, respectively. This was the first time PCB-contaminated oil was sampled. It should be noted that these manholes represent the lowest spots in this section of the TMD[2]. Therefore, accumulation in these manholes was not be interpreted to indicate that oil was entering at these locations, but rather that it was settling at these locations.

Oil Adhering to the Treatment System Suction Head at M7183

In April 2010, the treatment system was dismantled, all equipment and hardware were either decontaminated or disposed of and the trailer was turned over to MDEQ.

Table 2. Treatment System Influent/Effluent Sampling Data

Date	Location	Total PCB concentration (µg/l)		Removal Efficiency‡
		Influent	Effluent †	
10/15/08	M7178	610	25	95.902%
10/24/08	M4281/M4335	690	11	98.406%
10/29/08	M7183	63,000	110	99.825%
11/24/08	M7183	9,300	64	99.312%
11/25/08	M4334	6,100	9.4	99.846%
09/16/09	M4334	6,200	0.31	99.995%
10/12/09	Outfall	110	< 0.10	99.909%
10/20/09	M4266	1,400	< 0.20	99.986%
10/27/09	M7184	210	0.35	99.833%
11/03/09	M7178	70,000	0.47	99.999%
11/10/09	M4335	120	< 0.20	99.833%
11/17/09	M6972	6,100	< 0.20	99.997%
11/23/09	Outfall	2,700	< 0.20	99.993%
11/30/09	Outfall	1,200	< 0.20	99.983%
12/07/09	Outfall	440	< 0.20	99.955%

† Effluent concentrations > 0.20 µg/l violated the NPDES permit associated with the treatment system. As a result, modifications to the treatment process were made to reduce effluent concentrations.
‡ For less than values, the detection limit (0.10 or 0.20 µg/l) was used in determining the removal efficiency.

[2] Based on as-built drawings dated March 2002.

3.2 EPA Drain Clean Out

The presence of PCB-contaminated oil, found during the drain cleaning in November 2009, prompted the City to request additional federal assistance. This request resulted in the EPA removing the oil from the drain in December 2009 using oil snares. EPA subsequently re-cleaned the TMD and conducted preliminary source investigations in March/April 2010.

Typical EPA-Installed Weir

3.3 Weir Installation

A total of 17 weirs were installed in the TMD. AEW installed two weirs at manholes M7184 and M7182 in December 2009 and the EPA installed 15 additional weirs at select manholes along Harper Ave. and Bon Brae St. in April 2010. Each weir was installed just downstream of the manhole structure, so field staff could monitoring any accumulated sediment from the street without having to enter the drain. The EPA weirs are made of steel, while the AEW weirs consisted of sand bags. The weir locations are depicted with the sediment and oil results on Figure 7.

3.4 Oil Snare Installation and Replacement

On February 27, 2011 to help prevent the migration of PCB-contaminated oil, the EPA used oil snares to remove the oil that had pooled at M4263, M4262, M7179, M4335, M7183, and M4334. Oil snares were attached to a heavy chain and lowered to the bottom of each manhole, thereby allowing oil to adsorb to the snares. The snares were removed and inspected for oil. If oil was found, the snares were disposed of and the process was repeated until no oil was found on the snares. Based on the amount of oil found, snares were left in the four manholes along Bon Brae St. (M7179, M4335, M7183 and M4334).

Oil Snare String Replacement

Oil snare monitoring and replacement was conducted during each sediment monitoring event beginning in April/May 2011. The oil snares were inspected after they were removed from the drain. They were often covered with black material caused by accumulated fine sediment and they occasionally had patches of brown sticky material. When the brown material did not wash off a gloved-hand, it was assumed to be oil. During the first snare monitoring event, all snares were replaced regardless of oil detection. The new snare strings were tied off to the manhole rungs which allow for easier retrieval. On subsequent monitoring events, snare strings were replaced only if oil was detected. Table 3 provides the times when oil was found on snares and when they were replaced.

Table 3. Replacement Frequency for Oil Snares

Manhole	Feb 2011	April/May 2011	June 2011	Aug 2011
M4334	Initial Installation	Replaced	No oil found	No oil found
M7183	Initial Installation	Replaced	No oil found	No oil found
M4335	Initial Installation	Replaced	Oil found. Replaced	No oil found
M7179	Initial Installation	Oil found. Replaced	Oil found. Replaced	Oil found. Replaced

In comparing the oil snare observations shown in Table 3 with the results to be discussed in Table 6, the presence of oil on the snares was not always consistent with whether or not the field team found oil while probing to evaluate sediment depth. During the June 2011 event, oil was found on the probe at M7183, M4335, and M7179, but the snare at M7183 did not have oil on it. Similarly during the August 2011 monitoring event, oil was not found on the snare at M4335, but was found on the sample probe.

4.0 MONITORING RESULTS

This section of the report summaries the results of the groundwater, storm water and sediment samples collected during the project period. Historical sampling data is provided for comparison. Section 4.1 describes an investigational sampling effort that was conducted after oil was initially discovered during the TMD cleaning. Sections 4.2 – 4.4 discuss the routinely collected monitoring data.

The PCB mixture detected in the vast majority of samples collected during the project period was Aroclor 1242. However, two samples contained Aroclor 1248. The presence of this Aroclor was likely due to an analytical anomaly and does not necessarily indicate the presence of another PCB mixture.

Field photographs are provided in Appendix E and laboratory reports are included in Appendix F.

4.1 INVESTIGATIONAL SAMPLING

The discovery of PCB-contaminated oil during the drain cleaning prompted some investigational sampling upstream of M7179. On November 30, 2009, dark staining was observed under the two catch basin inlets draining to M7178 (Bon Brae west of Harper at the alley). This seemed significant because this manhole was lined during the 2006 EPA mobilization. A wipe sample was taken from the wall of the manhole structure under each of the two inlets. These samples revealed total PCB concentrations of 210 and 120 µg/100 square centimeters (cm^2) for the south and north lead, respectively. These values are consistent with the wipe sample collected at the same manhole following drain cleaning activities in November 2002 (see Figure 7 and Attachment 1 of the *Federal On-scene Coordinator's Report for Ten-Mile Polychlorinated Biphenyl Site Removal Action* August 4, 2004.).

In addition, a sediment sample was taken from about 3 feet up the north lead near a crack in the pipe. This sample had total PCB concentrations of 30 mg/kg. This value is consistent with the PCB concentrations found during the EPA/MDEQ's 2005 soil boring efforts (see Figure 6 of *April-May Site Investigation Report and Focused Feasibility Study for Saint Clair Shores Drain Site - Volume 1* dated March 2006).

4.2 GROUNDWATER MONITORING RESULTS

Total PCB concentrations in groundwater ranged from 0.46 to 3,800 µg/L (see Figure 3). Since the wells are all installed within the TMD backfill material, these concentrations represent the water quality within the drain trench outside of the storm drain and are not necessarily indicative of what would be found in the native clay soils.

The highest groundwater concentrations were generally found in MW3 located at the southeast corner of Bon Brae and Harper). The lowest concentrations were found at MW5 located at Lakeland and Harper (see Table 4).

Figure 3. Groundwater Sampling Results

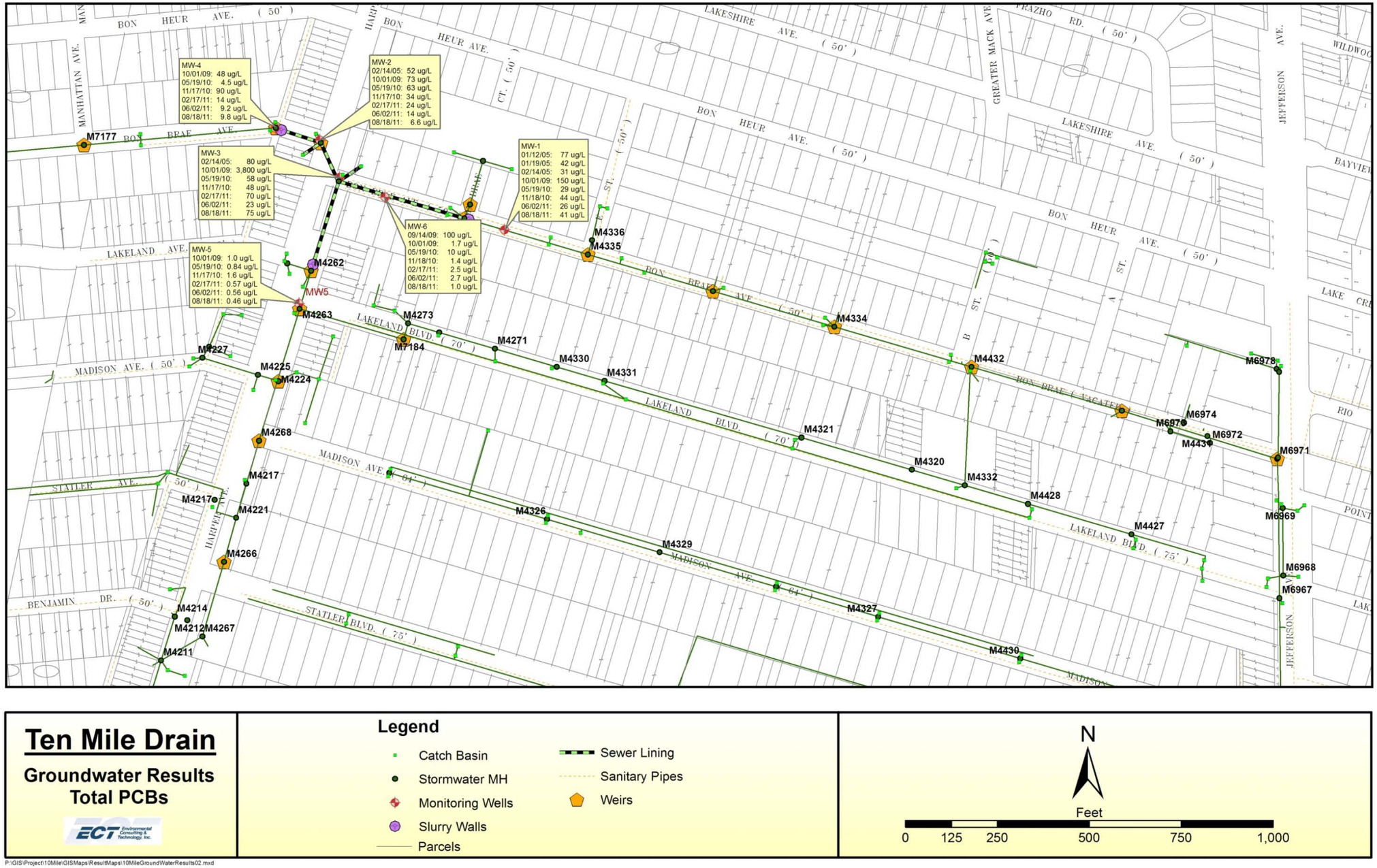


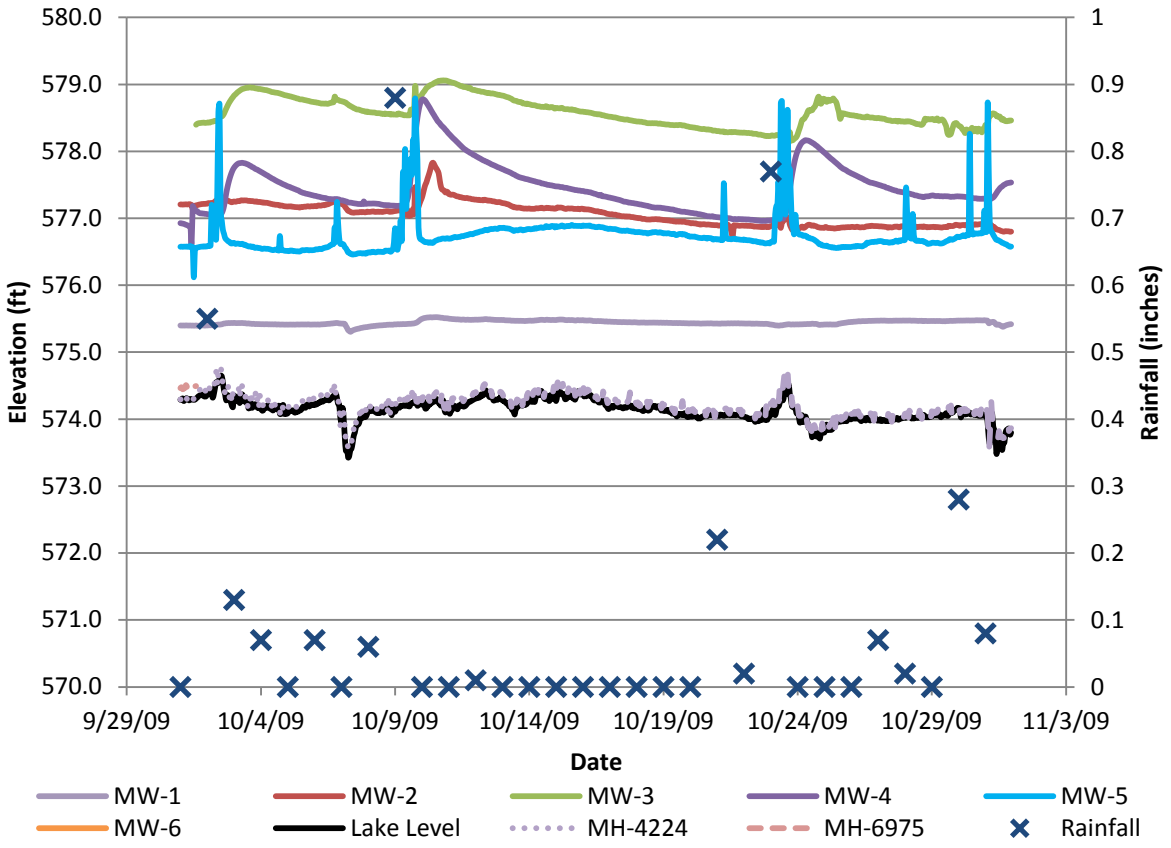
Table 4. Total PCB Concentrations in Groundwater

Well ID	Total PCB Concentration (µg/L)										
	1/12/05	1/19/05	2/14/05	9/14/09	10/01/09	5/19/10	11/17/10 11/18/10	2/17/11	6/02/11	8/18/11	Average/ Median
MW1	77	42	31		150	29	44	‡	26	41	55/42
MW2			52		73	63	34	24	14	6.6	38/34
MW3			80		3,800	58	48	70	23	75	593/70
MW4					48	4.5	90	14	9.2	9.8	29/12
MW5					1.0	0.84	1.6	0.57	0.56	0.46	0.83/0.71
MW6				100†	1.7	10	1.4	2.5	2.7	1.0	17/2.5

† Analyzed by RTI Laboratory. All other samples analyzed by Paragon Laboratories, Inc.
‡ Sample not taken due to ice buildup within the well.

Groundwater elevations were consistently higher than storm water elevations indicating that groundwater would tend to infiltrate into the lower sections of the TMD. The storm water level in the drain is consistent with the level in Lake St. Clair. Rain events routinely cause groundwater levels to fluctuate (due to surface infiltration through the well caps which were left open for venting). Storm water levels seemed less variable during rain events. These phenomena are depicted in Figure 4.

Figure 4. Groundwater and Storm Water Elevation Data

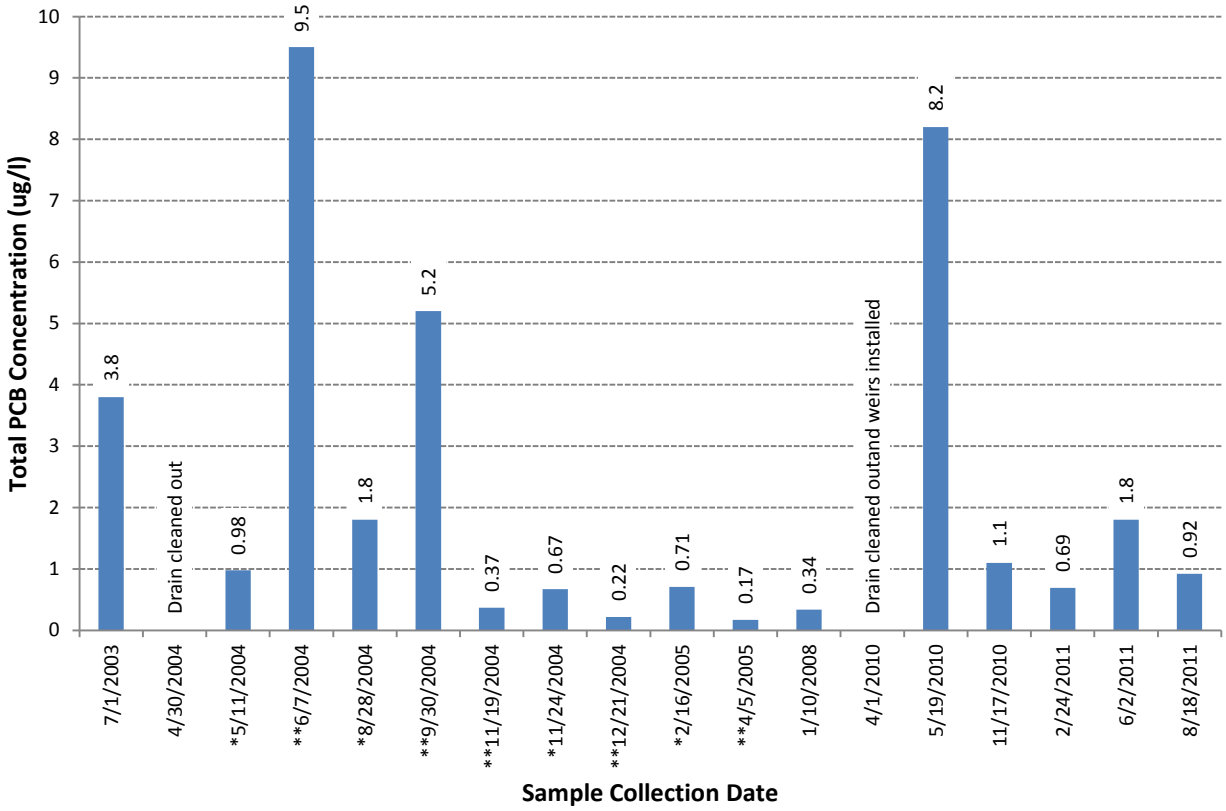


MW1 is the well located furthest to the east (closest to the Lake) and the only well located outside the slurry walls. Groundwater elevations at MW1 were typically lower than at the other wells, but still higher than storm water levels. When the drain was dewatered for cleaning in March and April 2010, the groundwater elevation at MW1immediately reduced until after the drain was allowed to refill. During this time, the elevations in the remaining wells reduced as well, but not as quickly or as much as MW1. Graphs of the groundwater data are provided in Appendix G.

4.3 Surface Water Results

Over the project period, total PCB concentrations in the outlet samples ranged from 0.69 to 8.2 µg/L as shown in Figure 5. These results are consistent with historic concentrations, which ranged from 0.17 to 9.5 µg/L. PCB concentrations appear to be highest following the drain cleanings, which were completed in April 2004 and April 2010 as depicted on Figure 5.

Figure 5. Outfall Water Column Total PCB Concentrations



*Collected during or following wet weather events (> 0.25" of precipitation over 24 hours).
**Collected during dry weather (< 0.1" precipitation over 24 hours).

4.4 Sediment and Oil Results

4.3.1 Pre-weir Installation Results

During the 2008 sampling event, no sediment was available for sampling in some of the lined portions of the drain. At most locations where sediment was found, PCB concentrations were lower than previous results; however, the concentrations were still elevated. In addition, PCB

concentrations (530 mg/kg) within the sediment trap at the outfall were fairly consistent with previous results. Field staff found that the sediment from M7183 had an oily consistency. The pre-weir installation sampling results are shown in Figure 6.

Sediment levels were measured in each sampled manhole, as well as at the outlet. Most of the manholes had less than 6 inches of sediment. The exception to this was manhole M4334, which had 1.5 feet. The outlet contained an estimated 13 cubic yards of sediment.

The drain and outlet were subsequently cleaned out and weirs were installed between 2009 and 2010 to help prevent migration of the PCBs to the canals as described in Section 3.0.

4.3.2 Post-weir Installation Results

After the weirs were installed, 10 sampling rounds were conducted. Individual samples had Total PCB concentrations from less than 1 mg/kg at the two most upstream manholes on Harper Ave. to greater than 10,000 mg/kg at four manholes along Bon Brae St.: M7179, M4335, M7183 and M4334 (see Table 4 and Figure 7). Several locations had insufficient sediment present, so no sample could be collected.

Although lower in concentration than the rest of the project area, PCBs were consistently present in sediment at the most upstream manholes on Harper Ave. (M4266 and M4268). Concentrations at these manholes were generally higher in 2011 than in 2010.

Oil was found adhered to the sample probe at several locations. However, there were sufficient volumes for sampling at only five manholes during one or more sampling rounds. Total PCB concentrations for the oil ranged from 23 to 3,000,000 mg/kg (see Table 6). Oil was occasionally found in manholes M4263, M4262, M4335, M7183 and M4334 and consistently in manhole M7179. In many cases oil was present in manholes that did not have sediment as shown in Table 5.

The oil exhibited a consistent brown color and was tacky to the touch, similar to the consistency of syrup. It becomes less viscous (runnier) when exposed to warmer temperatures (such as when pulled out of the drain on a hot day). On occasion, thicker oil globules, whose viscosity did not change, were observed on the sample probe.

Even at those locations where oil was not found on the sampling probe, it was not uncommon for an oil sheen appeared on the water surface once the drain contents were disturbed. These sheens may have been caused by other sources of oil commonly found in urban storm water. The presence of oil and/or sheen at each manhole is represented in Table 6 using colored shading. On occasion there appeared to be oil beads suspended in the water column at some of the manholes. This phenomenon was noted by field staff in July 2010 at manholes M7182 and M4432.

With a few exceptions, less than 2 inches of sediment/debris had accumulated behind the weirs as shown in Table 6. The most upstream manhole on Harper Ave. (M4266) had the most accumulated material at 2 to 5 inches.

Figure 6. Pre-Weir Installation Sediment Sampling Results

Table 5. Post-weir Installation Total PCB Concentrations in Storm Drain Sediment and Oil (mg/kg)

MH ID	Sample Matrix	May 2010	July 2010	Aug 2010	Oct 2010	Nov 2010	Dec 2010	Feb 2011*	Apr/May 2011	June 2011	Aug 2011	Median
Harper Ave. Locations (upstream to downstream)												
M4266	Sediment	1.2	3.2	1.3	3.9	4	0.98	2.8	10	30	3.2	3.2
M4268	Sediment	NS	14	3.8	5.3	7.1	0.96	14	51	30	31	14
M4224	Sediment	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
M4263	Sediment	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
	Oil	NS	NS	NS	20,000	46,000	12,000	75	NS	NS	NS	16,000
M4262	Sediment	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
	Oil	NS	NS	NS	NS	73,000	NS	NS	NS	4,000,000 †	NS	73,000
Lakeland St. Location												
M7184	Sediment		NS	NS	NS	NS	NS	NS	NS	NS	86	
Bon Brae St. Locations (upstream to downstream)												
M7177	Sediment	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
M7178	Sediment	NS	86	16	NS	NS	50	NS	NS	220	140	86
M7179	Sediment	NS	NS	NS	NS	14,000	NS	NS	NS	NS	NS	
	Oil	180,000	5,400	6,900	240,000	1,300	13,000	23	11,000	3,000,000 †	940	6,900
M4281	Sediment	NS	NS	290	NS	300	NS	NS	NS	430	480	365
M4335	Sediment	NS	9,300	NS	NS	NS	NS	NS	NS	69,000	5,200	9,300
	Oil	NS	NS	NS	180,000	100,000	NS	200,000 ‡	16,000	NS	550	100,000
M7183	Sediment	NS	900	590	350	2,700	NS	NS	17,000	14,000	1,000	1,000
	Oil	NS	NS	NS	NS	5,300	NS	41	NS	41	NS	41
M4334	Sediment	NS	370	800	2,200	680	NS	NS	3,800	980	31,000	980
	Oil	NS	NS	NS	NS	550	NS	NS	NS	NS	NS	
M4432	Sediment	NS	NS	NS	NS	NS	NS	NS	NS	210	330	270
M6975	Sediment	NS	NS	NS	NS	NS	NS	NS	NS	NS	390	
M6971	Sediment	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
Bon Brae Court Location												
M7182	Sediment	NS	NS	NS	NS	NS	NS	NS	NS	NS	1.5	

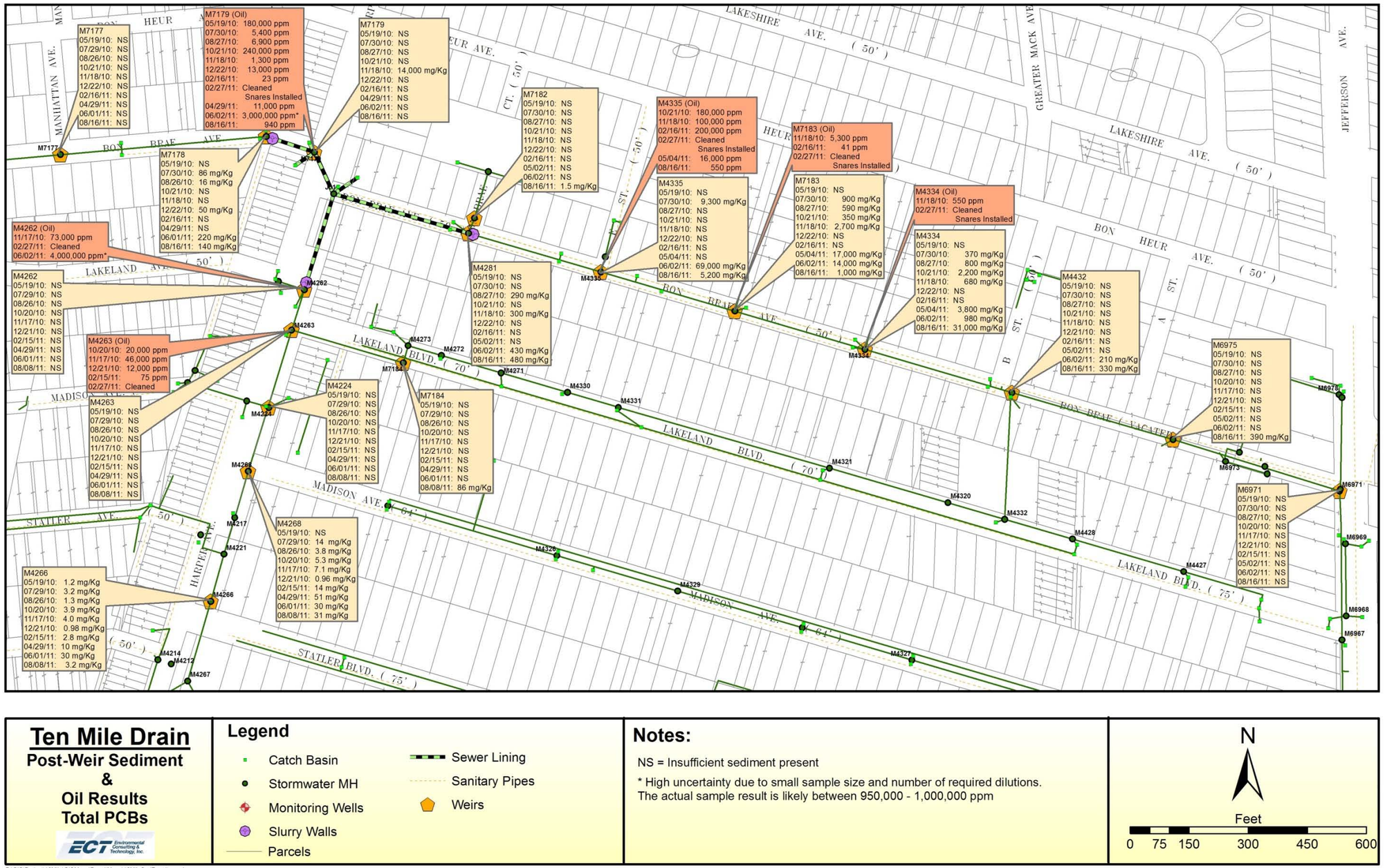
NS indicates that no sample was analyzed due to a lack of sufficient sample.
* Oil removed from the TMD using oil snares following this sampling event.
† Sample collected from oil beads suspended in water brought up in the ponar dredge. There is a high uncertainty in these values due to a small sample size, the number of required dilutions, and subtle differences between the sample and the known standard. The actual sample result is likely between 950,000 – 1,000,000 mg/kg (Personal communication with J. Spurr, Paragon Laboratory on 7/26/11).
‡ Sampled collected from the ponar dredge.

Table 6. Estimated Thickness of Sediment/Debris (inches)

MH ID	May 2010	July 2010	Aug 2010	Oct 2010	Nov 2010	Dec 2010	Feb 2011	Apr/May 2011	June 2011	Aug 2011
Harper Ave. Locations										
M4266	3	3	3	5	2	2	2	2	1.5	1
M4268	< 0.5	6	3	1	< 1	1	2	1	2.5	1.5
M4224	< 0.5	NONE	NONE	NONE	< 1	< 1	<1	NONE	NONE	NONE
M4263	1	NONE	NONE	1.5	1	1	1	NONE	NONE	1
M4262	NONE	NONE	NONE	NONE	1.5	< 1	<1	<1	NONE	NONE
Lakeland St. Location										
M7184		NONE	NONE	NONE	< 1	NONE	NONE	1	<1	<1
Bon Brae St. Locations										
M6971	NONE	< 0.5	< 0.5	NONE	< 1	1	<1	2	NONE	NONE
M6975	< 1	< 1	< 0.25	NONE	NONE	NONE	NONE	2	NONE	NONE
M4432	< 1	1.5	< 0.5	NONE	NONE	NONE	NONE	NONE	<1	<1
M4334	NONE	2	< 0.5	< 1	1	1	<1	<1	<1	0.5
M7183	< 0.5	2	< 0.5	< 1	1.5	1	1	1	1	<0.5
M4335	NONE	2	0.5	< 1	1	< 1	<1	NONE	<1	0.5
M4281	< 0.5	3	4	2	2	1	1	3	2.5	1
M7179	< 0.5	< 1	-	NONE	< 1	< 1	<1	NONE	NONE	NONE
M7178	< 0.5	1.5	3	2	1.5	1	1	NONE	1	1
M7177	< 0.5	NONE	< 0.25	1	1	1	1	NONE	NONE	NONE
Bon Brae Court Location										
M7182	NONE	< 0.5	< 0.25	1	1	< 1	<1	1	1	<1

Oil sheen on water before disturbing the sediment (no oil found on probe)
Oil found on probe (may or may not have been sufficient volume for sampling)
Oil sheen on water after disturbing the sediment (no oil found on probe).

Figure 7. Post Weir Installation Sediment and Oil Sampling Results



Ten Mile Drain

Post-Weir Sediment & Oil Results Total PCBs

ECT Environmental Consulting & Technology, Inc.

Legend

- Catch Basin
- Stormwater MH
- Monitoring Wells
- Slurry Walls
- Parcels
- Sewer Lining
- Sanitary Pipes
- Weirs

Notes:

NS = Insufficient sediment present

* High uncertainty due to small sample size and number of required dilutions. The actual sample result is likely between 950,000 - 1,000,000 ppm

N

Feet

0 75 150 300 450 600

5.0 CONCLUSIONS

The TMD continues to be impacted by PCBs. The CIPP liner and slurry walls installed in 2006 have not eliminated the infiltration/inflow of PCBs into the TMD. Oil containing high levels of PCBs, appears to be entering the drain at more than one location. Based on the information provided in this report and historic knowledge of the site, ECT makes the following observations:

Oil

1. Since sediment was often unavailable, the sampling and analysis of oil concentrations has aided this investigation.
2. The total PCB concentration of the oil entering the TMD is extremely high with seven samples above 10% PCBs by weight.
3. The oil has the consistency and look of maple syrup and on occasion it is thicker like tar.
4. The oil typically lies on the bottom of the water column. However, when disturbed during sample collection, it can form small beads that move within the water column.
5. The viscosity of the oil appears to change with temperature. The oil is less viscous in warmer temperatures.
6. The highest oil concentrations (> 10,000 mg/kg) have been found behind the weirs at
    a. M7179 (southwest corner of Bon Brae and Harper),
    b. M4335 (Bon Brae at E Street),
    c. M4263 (Harper at Lakeland), and
    d. M4262 (Harper north of Lakeland).
7. The oil appears to be entering the TMD in at least three locations:
    a. Between the weirs at M7178 and M7179 (Bon Brae west of Harper),
    b. Up gradient of the weir at M4335 (Bon Brae at E Street), and
    c. Up gradient of the weir at M4262 (Harper near Lakeland).
8. Based on the lower PCB concentrations and frequency of observation, the oil collecting behind the Bon Brae weirs at M7183 (vacated D Street) and M4334 (vacated C Street) may be coming from the upstream weir at Bon Brae and E Street.
9. It is unknown whether the oil is entering the TMD via infiltration from drain trench or inflow from a lateral connection.

Investigations near the Alley

10. The PCB contamination on the newly lined manhole structure located at Bon Brae and the alley was either caused by contaminated storm water surcharging in the TMD or by seepage of contaminated material (groundwater, oil or sediment) into the TMD.
11. The PCB concentration of the sediment sample collected from the north catch basin lead located at Bon Brae and the alley likely indicates that the surrounding backfill/soils are impacted by PCBs at an elevation higher than the crown of the 10 Mile Drain.

Sediment Accumulation

12. Sediment levels behind the individual weirs have fluctuated over time. The maximum amount of accumulated sediment was 6 inches at any given time and location.
13. Based on the ability to collect a sediment sample, sediment is more frequently found behind the weirs at M4266, M4268, M7178, M7183 and M4334 than in other manholes.

Sediment Extraction/Storm Water Treatment System

14. The sediment extraction and storm water treatment system was effective in cleaning out contaminated material from the TMD. However, it was not consistently able to meet the NPDES effluent limit when PCB-oil was encountered in the TMD.
15. The cost to design, build, operate, permit and decommission the treatment system was $245,000 or $9.07/gallon of water treated. The treatment system was slightly more cost effective than pumping and hauling contaminated material from the drain assuming $10/gallon for pump, haul and disposal.

Groundwater

16. With the exception of the oil sheen previously found during the installation of MW2, oil has not been detected in the monitoring wells.
17. The highest groundwater concentration was 3,800 µg/L found in MW3 (southeast corner of Bon Brae and Harper). The next highest values were found in MW1 (150 µg/L) and MW6 (100 µg/L). The least impacted groundwater is found at MW5 (Harper at Lakeland).
18. MW6 was not effective in collecting PCB-contaminated oil. This is likely because the well was not installed in an area that had oil accumulated in the backfill or the oil was at an elevation lower than the invert of the sump.
19. The storm water level in the drain is in direct continuity with the lake. However, groundwater elevations were consistently higher than storm water elevations indicating that groundwater would tend to infiltrate into the lower sections of the TMD. This could be the mechanism by which PCBs are entering the TMD.
20. The CIPP liner and slurry walls have reduced the connectivity between storm water and groundwater at the wells inside the slurry walls.

Surface Water

21. Surface water concentrations at the outlet generally are under 2 µg/L with higher concentrations appearing following drain cleaning activities. However, PCB concentrations consistently exceed the MDEQ's Part 201 groundwater/surface water interface criteria of < 0.2 µg/L for the protection of aquatic organisms.

6.0 RECOMMENDATIONS

Continued monitoring of the TMD outlet and weirs is recommended. At a minimum monitoring should evaluate PCB concentrations in storm water and sediment at the outlet and oil and sediment behind the weirs. Sediment levels should also be measured. Monitoring should continue even after any remedial measures are employed to determine the success of these measures.

The weirs should be periodically maintained, as PCB-contaminated oil and sediment accumulate, to reduce migration to the canals. Maintenance should include removing any accumulated oil and sediment and replacing the oil snares. The monitoring data should be used to drive the maintenance schedule.

Interim remedial measures are also recommended to intercept the PCBs before they reach the TMD. This could include installation of collection sumps near the heavily impacted manholes as determined by this project and the EPA's March/April 2011 source area investigation results.

When the TMD is cleaned out in the future, sediment removal without dewatering should be considered as a potential option.